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METHOD FOR MELTING METALLIC SCRAP AND APPARATUS THEREFOR
[Kinzoku sukurappu no youkaihouhou oyobi sono souchi]

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[Claims] /*

[Claim 1] A method for melting metal scraps characterized by the impurities attached to metal scraps being detached and removed in a process in which metal scraps are preheated by exhaust gas from the melting furnace prior to being charged into the melting furnace.

[Claim 2] A method defined in Claim 1 for melting metal scraps, wherein impurities are separated by the metal scraps being oscillated.

[Claim 3] A method defined in Claim 1 for melting metal scraps, wherein metal scraps and impurities separated from them are fractionated and wherein the metal scraps are then fed selectively to the melting furnace.

[Claim 4] A method defined in Claim 1 for melting metal scraps, wherein the oxygen potential and temperature of the exhaust gas from the melting furnace are adjusted to a range in which impurities attached to the metal scraps become oxidized.

[Claim 5] With respect to a metal-scrap melting device that is the combination of a metal-scrap melting furnace and a preheating furnace that uses exhaust gas from said melting furnace,

a metal-scrap melting device wherein said preheating furnace has installed in it: a detaching mechanism, which forcibly separates impurities by oscillating metal scraps; and a fractionating mechanism, which fractionates metal scraps and impurities and which selectively feeds the metal scraps to the melting furnace.

[Claim 6] A metal-scrap melting device defined in Claim 5, wherein at least part of the preheating furnace forms a transfer passage through

* Claim and paragraph numbers correspond to those in the foreign text.

which metal scraps are guided to the melting furnace.

[Detailed Description of the Invention]

[0001] [Field of Industrial Application]

The present invention relates to a method for melting metallic scrap having a low impurity concentration and to an improvement on techniques for melting metal scrap after preheating the metal scrap by utilizing the exhaust gas of a metal-scrap melting furnace.

[0002] [Related Art of the Invention]

In recent years, the generated amount of metal scraps represented by iron has increased, and recycling of these metal scraps is being highlighted from the perspectives of environmental conservation and cost reduction for metal production. In the case of iron, for example, the sources of iron utilized for steelmaking have included hot metals obtained by melting and reducing iron ores in a blast furnace, cold metals obtained by cooling down or solidifying [the hot metals], iron scraps generated during the fabrication of steel materials, and iron scraps generated by the aging of buildings, mechanical products, etc.

[0003] Since the basic component of hot irons and cold irons is iron ores, the concentrations of the impurities contained are low during the steelmaking stage of these iron sources, and therefore, high-quality products can be obtained from them. However, from the overall viewpoints of iron making and steelmaking, there are disadvantages in that a great amount of energy is required to melt and reduce iron ores and in that it requires an investment in large-scale facilities to be utilized for the beneficiation of raw materials such as iron ores as well as for the

blast furnace and converter furnace.

[0004] As opposed to this, using iron scraps as the source of iron has advantages in that: the amount of consumed energy decreases because of the lack of need for the heat used for reduction; the beneficiation process performed on raw materials becomes simpler; and it becomes unnecessary to use large-scale facilities and devices.

[0005] Examples in which such iron scraps are utilized as the source of iron include: the EOF process mentioned in Iron and Steel Engineer, vol.62 (1985), No.10, p.16; and the CONSTEEL process mentioned in Iron and Steelmaker, May 1986, p.37.

[0006] These methods realize conditions that are advantageous in terms of heat efficiency by utilizing the exhaust gas from a steelmaking furnace for the preheating of scraps. However, they are not equipped with the function for removing impurities, which are fed to the preheating furnace by being mixed with the scraps, as well as oxides and scrapings, which are generated during the scrap preheating process, by taking into account that they will be carried into the steelmaking furnace. For this reason, if the required product quality is high, it becomes necessary to utilize expensive scraps having low impurity concentrations as the source of iron, and this consequently increases the cost of the main raw materials and makes it economically difficult to carry out the operation.

[0007] [Problems that the Invention is to Solve]

In light of this, the aim of this invention is to supply a method for melting low-impurity-concentration metal scraps that is capable of preventing impurities and metal oxides from being mixed into the

metal-scrap melting furnace as well as to supply a melting device that suits this method advantageously.

[0008] [Means for Solving the Problems]

This invention is a method for melting metal scraps and is characterized by detaching and removing the impurities attached to the metal scraps during the process in which metal scraps are preheated by using the exhaust gas from the melting furnace and which is carried out prior to charging the melting furnace with the metal scraps.

[0009] Therefore, it is advantageous from the aspect of practical application to: detach impurities by applying oscillation to the metal scraps; fractionate the metal scraps and the impurities separated from them; selectively feed the metal scraps to the melting furnace; and control the oxygen potential and temperature of the exhaust gas from the melting furnace to ranges in which the impurities attached to the metal scraps will become oxidized.

[0010] Moreover, with respect to a metal-scrap melting device which is the combination of a metal-scrap melting furnace and a preheating furnace that utilizes the exhaust gas from the melting furnace, this invention is a metal-scrap melting device in which the preheating furnace has installed in it a detaching mechanism, which forces impurities to become detached by applying oscillation to the metal scraps, and a fractionating mechanism, which fractionates metal scraps and impurities and selectively supplies the metal scraps to the melting furnace.

[0011] In this case, it is advantageous to assign at least part of the preheating furnace as the transfer passage for guiding the metal scraps

to the melting furnace.

[0012] Moreover, the impurities attached to the metal scraps include not only the impurities supplied to the preheating furnace while attached to the surfaces of the metal scraps or mixed in with the scraps but also the oxides and scrapings that were generated during the scrap preheating process.

[0013] Next, the method of the invention for melting metal scraps will be described in detail with reference to Figure 1 based on an example of iron scraps. First, iron scraps 1, which are the raw materials to be fed, are charged into the preheating furnace 3 from the charging opening 2, are transferred to the melting furnace 4, which is a cupola or electric furnace, etc., by using the preheating furnace 3 as a transfer passage, and are then charged into the melting furnace 4. After that, the iron scraps 1 are melted by using coke or limestone, which is charged separately.

[0014] The preheating furnace 3 is a structure which is disposed in the space between the charging opening 2 and an inlet 5 for iron scraps 1 provided to the melting furnace 4, and also functions as a transfer passage for the iron scraps 1. Exhaust gas from the melting furnace 4 is guided from the inlet 5 into the preheating furnace 3, and the preheating and partial oxidization of the iron scraps 1 are accomplished by means of the combustion heat obtained by burning the exhaust gas by an afterburner 6.

[0015] Furthermore, the preheating furnace 3 is equipped with a detaching mechanism 7, which separates the iron scraps from the impurities that have attached to the iron scraps as well as the oxidized film formed

on the surfaces of the iron scraps during their preheating.

[0016] In this case, a mechanism for applying oscillation to the preheating furnace 3 is recommended as the detaching mechanism 7. In other words, by oscillating the preheating furnace 3, which will be the transfer passage, the iron scraps 1 are transferred to the melting furnace 4, and oscillation is applied to the iron scraps 1 to detach the impurities 8 from the iron scraps. The mechanism employed to apply oscillation utilizes the excitation force generated by the rotation of an oscillation motor or cam.

[0017] Next, the detached iron scraps 1 and impurities 8 are fractionalized by the fractionating mechanism provided on the output side of the preheating furnace 3, and only the iron scraps 1 become charged into the melting furnace 4. Since this fractionating mechanism 9 turns impurities into fine grains as a result of the preheating and, in particular, oscillation of the iron scraps 1. Therefore, a lattice capable of fractionating the impurities based on their grain size differences from those of iron scraps was utilized. Other than this, it is permissible to employ a method by which gas is sprayed onto the mixture of iron scraps and impurities in order to fractionate them by using the kinetic energy (wind pressure) of this gas since the weight volume ratios (single-body weights if the grain sizes are the same) are different between the iron scraps and impurities.

[0018] Moreover, iron scraps 1 from which impurities have been removed are charged continuously or semi-continuously from the top of the melting furnace 4 into the furnace together with coke or limestone, the iron scraps

1 are then melted by feeding air or oxygen-rich air into the furnace from the tuyere 10 provided to a lower part of the melting furnace 4, and the hot metal is extracted from the taphole 11.

[0019] Moreover, although the iron-scrap conveying surface of the preheating furnace is horizontal, and [iron scraps] are transferred to the melting furnace side by means of oscillation in the example of Figure 1, it is permissible to instead transfer the iron scraps by tilting the conveying surface toward the melting furnace.

[0020] [Operation of the Invention]

Unlike the method used for a blast furnace or the like in which iron ore is utilized, a method for making pig iron in which iron scraps are utilized as the source of iron does not require that iron oxide be reduced and only requires heat necessary for heating and melting. Therefore, the amount of energy used can be small, making [the method] more economical.

[0021] Moreover, since a vertical furnace is utilized for the steelmaking process (scrap melting process), inexpensive carbon materials, such as coke, can be utilized as the source of heat (source of energy), and it is also possible to maintain a low exhaust-gas temperature because of the characteristics of the furnace. Therefore, the heat efficiency can be improved, which is advantageous in terms of both the amount of energy used as well as cost. Needless to say, it is permissible to utilize a regular electric furnace for the iron-making process (scrap melting process) in locations in which electric energy is inexpensive. Furthermore, by connecting the metal-scrap preheating furnace to the melting furnace of these iron scraps, it is possible to directly utilize the exhaust gas

from the melting furnace for the preheating of metal scraps.

[0022] What becomes an issue here is the impurities attached to the metal scraps and the oxides generated during the preheating process in the preheating furnace being carried into the melting furnace in an inescapable manner.

[0023] Therefore, according to this invention, impurities mixed with or attached to metal scraps or oxides chemically generated or scrapings physically produced during the preheating process in the preheating furnace are detached and fractionated from the iron scraps in the preheating process. Then, only the iron scraps are selectively charged into the melting furnace. As a result, even if inexpensive scraps having high impurity concentrations are utilized, the impurity concentrations of the hot metal obtained in the melting furnace can be kept relatively low, allowing the cost of the main materials to be lowered. Also, since the impurity concentrations of the hot metal obtained from the melting furnace can be made low, the process for removing impurities during the steelmaking process can be simplified, realizing a reduction in the overall ore refining cost of the pig iron making process and steelmaking process.

[0024] The reason why impurities can be detached and fractionated as oxides and scrapings during the preheating process is as follows. In other words, impurities of the iron scraps are plating films on the scrap surface and consist of Cu, Sn, and Cr, and they become peeled off as small pieces as a result of these plating layers becoming brittle after being oxidized. Similarly, in a case in which metal, Al, is mixed with the scraps, Al becomes oxidized and turns into Al_2O_3, which can also be easily detached

from the iron scraps.

[0025] Meanwhile, although the Ni plating layer is resistant to oxidation, it is attached to the surfaces of the iron scraps and the iron itself becomes oxidized and separated as oxidized scales, Ni also becomes easily separated from iron. In other words, when iron scraps are preheated in a high-temperature oxidizing atmosphere, the surfaces of the scraps become oxidized and become separated easily as oxidized scales. Therefore, even if the non-iron metal itself does not become oxidized, it can separate more easily as a surface attachment.

[0026] Various experiments were performed extensively regarding the separation of impurities from iron scraps that occurs during the abovementioned preheating process. As a result, they revealed that: impurities mixed with iron scraps as well as most of the impurities attached to the surfaces of the iron scraps can be separated by carrying out a preliminary process in which iron scraps become preheated while oscillated; and impurities can be separated more efficiently by adjusting the oxygen potential and temperature of the exhaust gas emitted from the melting surface to be within the range in which the impurities attached to the metal scraps will become oxidized.

[0027] [Embodiment of the Invention]

In accordance with the illustration of Figure 1, iron scraps which were shredder scraps in the sizes of between 25 and 200 mm and which contained impurities consisting of Cu, Ni, Cr, and Sn in the total amount of 0.45wt% were melted to produce pig iron.

[0028] Moreover, a cupola having the capability of 5t/h was used

as the melting furnace. As for the operation conditions, blast furnace coke in the sizes of between 25 and 75 mm was fed at the blast air amount of 80 Nm^3/min and oxygen amount of 1.5 Nm^3/min. Moreover, exhaust gas from the melting furnace was introduced to the iron-scrap preheating furnace after being combusted by an afterburner in a manner such that the preheating gas temperature would be 800°C.

[0029] After carrying out an operation under the above conditions, the total amount of the impurities consisting of Cu, Ni, Cr, and Sn in the hot iron obtained from the cupola had decreased to 0.07wt%, and the impurity removal percentage was about 85%.

[0030] Moreover, a comparative operation was carried out by conforming to the same equipment and operation conditions used for the abovementioned embodiment but by keeping the impurity detaching mechanism 7 stopped. As a result, the total amount of the impurities, which consisted of Cu, Ni, Cr, and Sn, in the hot iron obtained from the cupola had only decreased to 0.43wt%, and the impurity removal percentage was only about 5%.

[0031] [Effects of the Invention]

When iron scraps are preheated and then melted by using the combination of a metal-scrap melting furnace and preheating furnace, the present invention is designed to separate the impurities mixed with metal scraps as well as the impurities generated during the metal scrap preheating process during the preheating process. Therefore, only iron scraps can be selectively fed to the meting furnace, making it possible to produce pig iron having low impurity concentrations.

[Brief Description of the Drawing]

[Figure 1] A model drawing illustrating the iron-scrap preheating furnace and melting furnace utilized for the method of this invention.

[Explanation of the Reference Numerals]

1 iron scrap

2 charging opening

3 preheating furnace

4 melting furnace

5 inlet

6 afterburner

7 separating mechanism

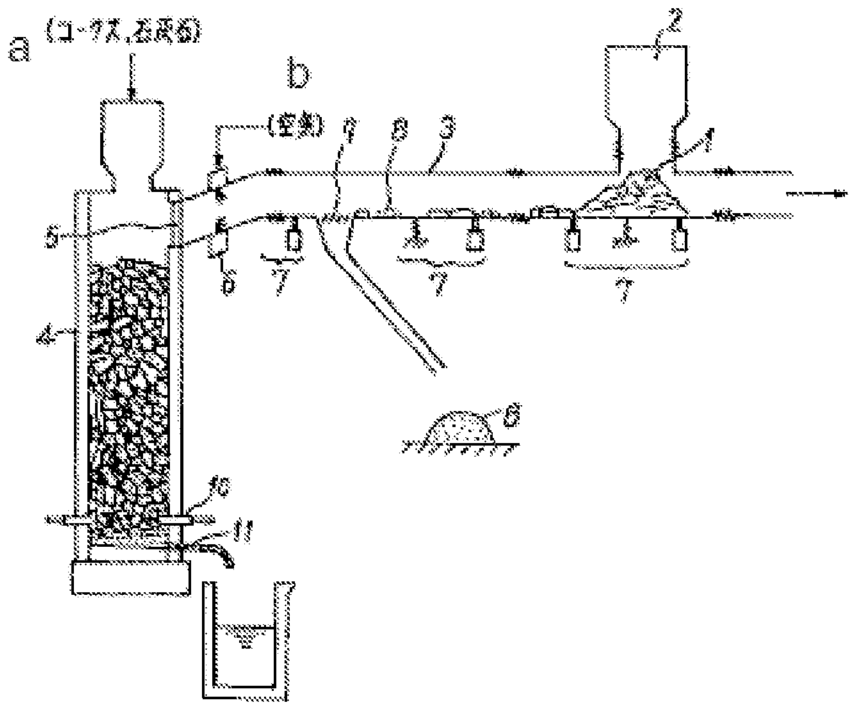
8 impurity

9 fractionating mechanism

10 tuyere

11 taphole

[Figure 1]



Key: a)(coke, limestone); b)(air)